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5     A Pharmaceutical Composition and Method of Modulating Cholinergic Function in a Mammal                    Background of the Invention

The present invention relates to pharmaceutical compositions for modulating cholinergic function in a mammal comprising a nicotinic receptor partial agonist compound in combination with an anti-emetic/anti-nausea agent and a pharmaceutically acceptable carrier.

10           The nicotinic receptor partial agonists (NRPAs) included herein are aryl fused azapolycyclic compounds. NRPAs are not limited to those described here. The term NRPA refers to all chemical compounds which bind at neuronal nicotinic acetylcholine specific receptor sites in mammalian tissue and elicit a partial agonist response. A partial agonist response is defined here to mean a partial, or incomplete functional effect in a given functional  
15     assay. Additionally, a partial agonist will also exhibit some degree of antagonist activity by its ability to block the action of a full agonist (Feldman, R.S., Meyer, J.S. & Quenzer, L.F. Principles of Neuropsychopharmacology, 1997; Sinauer Assoc. Inc.). The present invention may be used to treat mammals (e.g. humans) for inflammatory bowel disease (including but not limited to ulcerative colitis, pyoderma gangrenosum and Crohn's disease), irritable bowel  
20     syndrome, spastic dystonia, chronic pain, acute pain, celiac sprue, pouchitis, vasoconstriction, anxiety, panic disorder, depression, bipolar disorder, autism, sleep disorders, jet lag, amyotrophic lateral sclerosis (ALS), cognitive dysfunction, hypertension, bulimia, anorexia, obesity, cardiac arrhythmias, gastric acid hypersecretion, ulcers, pheochromocytoma, progressive supranuclear palsy, chemical dependencies and addictions (e.g., dependencies  
25     on, or addictions to nicotine (and/or tobacco products), alcohol, benzodiazepines, barbiturates, opioids or cocaine), headache, migraine, stroke, traumatic brain injury (TBI), obsessive-compulsive disorder (OCD), psychosis, Huntington's chorea, tardive dyskinesia, hyperkinesia, dyslexia, schizophrenia, multi-infarct dementia, age-related cognitive decline, epilepsy, including petit mal absence epilepsy, senile dementia of the Alzheimer's type (AD),  
30     Parkinson's disease (PD), attention deficit hyperactivity disorder (ADHD) and Tourette's Syndrome with a decrease in the incidence and severity of unwanted side effects such as nausea and/or stomach upset.

The present invention also relates to the combination use of NRPAs and anti-emetic/anti-nausea agents resulting in modulation of cholinergic function without nausea. The  
35     combination will provide an improved treatment paradigm than NRPAs alone.

It is expected that combinations of NRPAs with anti-emetic/anti-nausea agents would be useful in the treatment of inflammatory bowel disease (including but not limited to ulcerative colitis, pyoderma gangrenosum and Crohn's disease), irritable bowel syndrome,

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5 spastic dystonia, chronic pain, acute pain, celiac sprue, pouchitis, vasoconstriction, anxiety, panic disorder, depression, bipolar disorder, autism, sleep disorders, jet lag, amyotrophic lateral sclerosis (ALS), cognitive dysfunction, hypertension, bulimia, anorexia, obesity, cardiac arrhythmias, gastric acid hypersecretion, ulcers, pheochromocytoma, progressive supranuclear palsy, chemical dependencies and addictions (e.g., dependencies on, or addictions to nicotine  
10 (and/or tobacco products), alcohol, benzodiazepines, barbiturates, opioids or cocaine), headache, migraine, stroke, traumatic brain injury (TBI), obsessive-compulsive disorder (OCD), psychosis, Huntington's chorea, tardive dyskinesia, hyperkinesia, dyslexia, schizophrenia, multi-infarct dementia, age-related cognitive decline, epilepsy, including petit mal absence epilepsy, senile dementia of the Alzheimer's type (AD), Parkinson's disease  
15 (PD), attention deficit hyperactivity disorder (ADHD) and Tourette's Syndrome.

#### Summary of the Invention

The present invention relates to a pharmaceutical composition useful for modulating cholinergic function in a mammal comprising (a) a NRPA compound or a pharmaceutical acceptable salt thereof; (b) an anti-emetic/anti-nausea agent; and (c), a pharmaceutically  
20 acceptable carrier; wherein the active ingredients (a) and (b) above are present in amounts that render the composition effective in the treatment of a condition or disorder selected from inflammatory bowel disease (including but not limited to ulcerative colitis, pyoderma gangrenosum and Crohn's disease), irritable bowel syndrome, spastic dystonia, chronic pain, acute pain, celiac sprue, pouchitis, vasoconstriction, anxiety, panic disorder, depression,  
25 bipolar disorder, autism, sleep disorders, jet lag, amyotrophic lateral sclerosis (ALS), cognitive dysfunction, hypertension, bulimia, anorexia, obesity, cardiac arrhythmias, gastric acid hypersecretion, ulcers, pheochromocytoma, progressive supranuclear palsy, chemical dependencies and addictions (e.g., dependencies on, or addictions to nicotine (and/or tobacco products), alcohol, benzodiazepines, barbiturates, opioids or cocaine), headache,  
30 migraine, stroke, traumatic brain injury (TBI), obsessive-compulsive disorder (OCD), psychosis, Huntington's chorea, tardive dyskinesia, hyperkinesia, dyslexia, schizophrenia, multi-infarct dementia, age-related cognitive decline, epilepsy, including petit mal absence epilepsy, senile dementia of the Alzheimer's type (AD), Parkinson's disease (PD), attention deficit hyperactivity disorder (ADHD) and Tourette's Syndrome.

35 The aryl fused azapolycyclic compounds are selected from:

9-bromo-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-chloro-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-fluoro-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;

- 5 9-ethyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-methyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-phenyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-vinyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-bromo-3-methyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-  
10 one;  
3-benzyl-9-bromo-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-  
one;  
3-benzyl-9-chloro-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-  
one;  
15 9-acetyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-iodo-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-cyano-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-ethynyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-(2-propenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
20 9-(2-propyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-carbomethoxy-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-carboxyaldehyde-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-  
one;  
9-(2,6-difluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-  
25 one;  
9-phenyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-(2-fluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-  
one;  
9-(4-fluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-  
30 one;  
9-(3-fluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-  
one;  
9-(3,5-difluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-  
one;  
35 9-(2,4-difluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-  
one;  
9-(2,5-difluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-  
one;

- 5 6-methyl-5-oxo-6,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,8-triene;  
5-oxo-6,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,8-triene;  
6-oxo-5,7,13-triazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,8-triene;  
4,5-difluoro-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
5-fluoro-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene-4-carbonitrile;
- 10 4-ethynyl-5-fluoro-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
5-ethynyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene-4-carbonitrile;  
6-methyl-5-thia-5-dioxa-6,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,8-triene;
- 15 10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
4-fluoro-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
4-methyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
4-trifluoromethyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
4-nitro-10-azatrimethyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
7-methyl-5,7,13-triazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,5,8-tetraene;
- 20 6-methyl-5,7,13-triazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,5,8-tetraene;  
6,7-dimethyl-5,7,13-triazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,5,8-tetraene;  
6-methyl-7-phenyl-5,7,13-triazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,5,8-tetraene;
- 25 6,7-dimethyl-5,8,14-triazatetracyclo[10.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]hexadeca-2(11),3,5,7,9-pentaene;  
5,8,14-triazatetracyclo[10.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]hexadeca-2(11),3,5,7,9-pentaene;  
14-methyl-5,8,14-triazatetracyclo[10.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]hexadeca-2(11),3,5,7,9-pentaene;  
5-oxa-7,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,6,8-tetraene;  
6-methyl-5-oxa-7,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,6,8-tetraene;  
4-chloro-10-azatrimethyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;
- 30 10-azatrimethyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-trien-4-yl cyanide;  
1-(10-azatrimethyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-trien-4-yl)-1-ethanone;  
10-azatrimethyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-trien-4-ol;  
7-methyl-5-oxa-6,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2,4(8),6,9-tetraene;  
4,5-dichloro-10-azatrimethyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;
- 35 11-azatrimethyl-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene-5-carbonitrile;  
1-[11-azatrimethyl-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-5-yl]-1-ethanone;  
1-[11-azatrimethyl-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-5-yl]-1-propanone;  
4-fluoro-11-azatrimethyl-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene-5-carbonitrile;

- 5 5-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene-4-carbonitrile;  
6-methyl-7-thia-5,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6-methyl-5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6,7-dimethyl-5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;
- 10 5,6-dimethyl-5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,6,8-tetraene;  
5-methyl-5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,6,8-tetraene;  
6-(trifluoromethyl)-7-thia-5,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;
- 15 5,8,15-triazatetracyclo[11.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]heptadeca-2(11),3,5,7,9-pentaene;  
7-methyl-5,8,15-triazatetracyclo[11.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]heptadeca-2(11),3,5,7,9-pentaene;  
6-methyl-5,8,15-triazatetracyclo[11.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]heptadeca-2(11),3,5,7,9-pentaene;  
6,7-dimethyl-5,8,15-triazatetracyclo[11.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]heptadeca-2(11),3,5,7,9-pentaene;
- 20 7-oxa-5,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6-methyl-7-oxa-5,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
5-methyl-7-oxa-6,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6-methyl-5-oxa-7,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,6,8-tetraene;  
7-methyl-5-oxa-6,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,6,8-tetraene;
- 25 4,5-difluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
4-chloro-5-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
5-chloro-4-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
4-(1-ethynyl)-5-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
5-(1-ethynyl)-4-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
5,6-difluoro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2,4,6-triene;
- 30 6-trifluoromethyl-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2,4,6-triene;  
6-methoxy-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-6-ol;  
6-fluoro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-5-ol;
- 35 4-nitro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
5-nitro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
5-fluoro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene; and  
6-hydroxy-5-methoxy-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene and

- 5 their pharmaceutically acceptable salts and their optical isomers.  
 Preferably, the aryl fused azapolycyclic compounds are selected from:  
 9-bromo-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
 9-chloro-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
 9-fluoro-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
 10 9-acetyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
 9-iodo-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
 9-cyano-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
 9-carbomethoxy-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
 9-carboxyaldehyde-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-  
 15 one;  
 9-(2,6-difluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-  
 one;  
 9-phenyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
 9-(2-fluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-  
 20 one;  
 6-methyl-5-thia-5-dioxa-6,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,8-  
 triene;  
 4-fluoro-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
 4-trifluoromethyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
 25 4-nitro-10-azatricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
 6-methyl-5,7,13-triazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,5,8-tetraene;  
 6,7-dimethyl-5,8,14-triazatetracyclo[10.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]hexadeca-2(11),3,5,7,9-pentaene;  
 5,8,14-triazatetracyclo[10.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]hexadeca-2(11),3,5,7,9-pentaene;  
 5-oxa-7,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,6,8-tetraene;  
 30 6-methyl-5-oxa-7,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,6,8-tetraene;  
 10-azatricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-trien-4-yl cyanide;  
 1-(10-azatricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-trien-4-yl)-1-ethanone;  
 11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene-5-carbonitrile;  
 1-[11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-5-yl]-1-ethanone;  
 35 1-[11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-5-yl]-1-propanone;  
 4-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene-5-carbonitrile;  
 5-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene-4-carbonitrile;  
 6-methyl-7-thia-5,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;

- 5 6-methyl-5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6,7-dimethyl-5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6-methyl-7-oxa-5,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6-methyl-5-oxa-7,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,6,8-tetraene;  
5,6-difluoro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2,4,6-triene;
- 10 6-trifluoromethyl-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2,4,6-triene;  
6-methoxy-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
6-fluoro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene; and  
11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-5-ol  
and their pharmaceutically acceptable salts and their optical isomers..
- 15 The anti-emetics/anti-nausea agents are selected from the group consisting of: bismuth  
subsalicylate (Pepto-Bismol), chlorpromazine (Thorazine), dextrose/levulose/phosphoric acid  
(Emetrol), dimenhydrinate (Dramamine), diphenhydramine (Benadryl), dolasetron (Anzemet),  
dronabinol (Marinol), granisetron (Kytril), hydroxyzine (Atarax/Vistaril), meclizine  
(Antivert/Bonine), metoclopramide (Reglan), ondansetron (Zofran), perphenazine (Trilafon),  
20 prochlorperazine (Compazine), promethazine (Phenergan), scopolamine (Transderm Scop),  
trimethobenzamide (Tigan).
- Other anti-nausea/anti-emetics are selected from the group consisting of:  
(2S,3S)-3-(5-tert-butyl-2-methoxybenzyl)amino-2-(3-trifluoromethoxyphenyl)piperidine;  
(2S,3S)-3-(2-isopropoxy-5-trifluoromethoxybenzyl)amino-2-phenyl-piperidine;
- 25 (2S,3S)-3-(2-ethoxy-5-trifluoromethoxybenzyl)amino-2-phenyl-piperidine;  
(2S,3S)-3-(2-methoxy-5-trifluoromethoxybenzyl)-amino-2-phenylpiperidine;  
(2S,3S)-3-(5-tert-butyl-2-trifluoromethoxybenzyl)amino-2-phenylpiperidine;  
2-(diphenylmethyl)-N-(2-methoxy-5-trifluoromethoxy-phenyl)methyl-1-  
azabicyclo[2.2.2]octan-3-amine;
- 30 (2S,3S)-3-[5-chloro-2-(2,2,2-trifluoroethoxy)-benzyl]amino-2-phenylpiperidine;  
(2S,3S)-3-(5-tert-butyl-2-trifluoromethoxybenzyl)amino-2-phenylpiperidine;  
(2S,3S)-3-(2-isopropoxy-5-trifluoromethoxybenzyl)amino-2-phenylpiperidine;  
(2S,3S)-3-(2-difluoromethoxy-5-trifluoromethoxybenzyl)-amino-2-phenylpiperidine;  
(2S,3S)-2-phenyl-3-[2-(2,2,2-trifluoroethoxybenzyl)-aminopiperidine; or
- 35 (2S,3S)-2-phenyl-3-(2-trifluoromethoxybenzyl)]aminopiperidine;  
3-[N-(2-methoxy-5-trifluoromethoxybenzyl)-amino]-5,5-dimethyl-2-phenylpyrrolidine;  
3-[N-(2-methoxy-5-trifluoromethoxy-benzyl)amino]-4,5-dimethyl-2-phenylpyrrolidine;  
3-(2-cyclopropyloxy-5-trifluoromethoxybenzyl)amino-2-phenylpiperidine;



- 5 3-(2-cyclopropylmethoxy-5-trifluoromethoxybenzyl)amino-2-phenylpiperidine;  
3-(2-difluoromethoxy-5-phenylbenzyl)amino-2-phenylpiperidine;  
3-(5-cyclopropylmethoxy-2-difluoromethoxybenzyl)amino-2-phenylpiperidine;  
3-(2-methoxybenzyl)amino-2-(3-trifluoromethoxyphenyl)-piperidine;  
3-(2-methoxy-5-trifluoromethoxybenzyl)amino-2-(3-trifluoromethoxyphenyl)piperidine;  
10 2-phenyl-3-(5-n-propyl-2-trifluoromethoxybenzyl)amino-piperidine;  
3-(5-isopropyl-2-trifluoromethoxybenzyl)amino-2-phenylpiperidine;  
3-(5-ethyl-2-trifluoromethoxybenzyl)amino-2-phenyl-piperidine;  
3-(5-sec-butyl-2-trifluoromethoxybenzyl)amino-2-phenyl-piperidine;  
3-(5-difluoromethoxy-2-methoxybenzyl)amino-2-phenyl-piperidine;  
15 3-(2-methoxy-5-trifluoromethoxybenzyl)amino-2-phenylpyrrolidine;  
3-(2-methoxy-5-trifluoromethoxybenzyl)amino-2-phenylhomopiperidine;  
2-benzhydryl-3-(2-methoxy-5-trifluoromethoxy-benzyl)aminopyrrolidine;  
(2-methoxy-5-trifluoromethoxy-benzyl)-(2-phenyl-piperidin-3-yl)-amine;  
5-[(6-ethyl-2-phenyl-piperidin-3-ylamino)-methyl]-6-methoxy-3-methyl-1,1a,3,7b-  
20 tetrahydro-3-aza-cyclopropa[a]naphthalen-2-one;  
(6-methoxy-1-methyl-1-trifluoromethyl-isochroman-7-ylmethyl)-(2-phenyl-piperidin-3-  
yl)-amine;  
2-benzhydryl-3-(2-methoxy-5-trifluoromethoxy-benzyl)aminohomopiperidine;  
3-[2,5-bis-(2,2,2-trifluoroethoxy)benzyl]amino-2-phenylpiperidine;  
25 2-phenyl-3-(3-trifluoromethoxybenzyl)aminopiperidine;  
2-benzhydryl-3-(2-methoxy-5-trifluoromethoxybenzyl)-aminopiperidine;  
1-(5,6-difluorohexyl)-3-(2-methoxy-5-trifluoromethoxy-benzyl)amino-2-phenylpiperidine;  
1-(6-hydroxyhexyl)-3-(2-methoxy-5-trifluoromethoxy-benzyl)amino-2-phenylpiperidine;  
3-phenyl-4-(2-methoxy-5-trifluoromethoxybenzyl)amino-2-azabicyclo[3.3.0]octane;  
30 4-benzhydryl-5-(2-methoxy-5-trifluoromethoxybenzyl)-amino-3-  
azabicyclo[4.1.0]heptane;  
4-(2-methoxy-5-trifluoromethoxybenzyl)amino-3-phenyl-2-azabicyclo[4.4.0]decane;  
2-phenyl-3-(2-methoxy-5-trifluoromethoxybenzyl)-aminoquinuclidine;  
8-benzhydryl-N-(2-methoxy-5-trifluoromethoxybenzyl)-9-azatricyclo[4.3.1.0<sup>4,9</sup>]decan-7-  
35 amine;  
9-benzhydryl-N-(2-methoxy-5-trifluoromethoxybenzyl)-10-  
azatricyclo[4.4.1.0<sup>5,10</sup>]undecan-8-amine;

- 5           9-benzhydryl-N-(2-methoxy-5-trifluoromethoxybenzyl)-3-thia-10-azatricyclo-  
[4.4.1.0<sup>5,10</sup>]undecan-8-amine;  
          8-benzhydryl-N-(2-methoxy-5-trifluoromethoxybenzyl)-9-azatricyclo[4.3.1.0<sup>4,9</sup>]decan-7-  
amine;  
          5,6-pentamethylene-2-benzhydryl-3-(2-methoxy-5-trifluoromethoxybenzyl)amino-  
10   quinuclidine;  
          5,6-trimethylene-2-benzhydryl-3-(2-methoxy-5-trifluoromethoxybenzyl)amino-  
quinuclidine;  
          9-benzhydryl-N-((2-methoxy-5-trifluoromethoxyphenyl)-methyl)-3-oxa-10-azatricyclo-  
[4.4.1.0<sup>5,10</sup>]undecan-3-amine;  
15           8-benzhydryl-N-((2-methoxy-5-trifluoromethoxyphenyl)-methyl)-7-azatricyclo-  
[4.4.1.0<sup>5,10</sup>]undecan-9-amine; and  
          2-benzhydryl-N-((2-methoxy-5-trifluoromethoxyphenyl)-methyl)-1-azabicyclo-  
[3.2.2]nonan-3-amine;  
          (2S,3S)-3-(6-methoxy-1-methyl-1-trifluoromethylisochroman-7-yl)methylamino-2-  
20   phenylpiperidine;  
          (2S,3S)-3-[(1R)-6-methoxy-1-methyl-1-trifluoromethylisochroman-7-yl]methylamino-2-  
phenylpiperidine;  
          (2S,3S)-N-(5-isopropyl-2-methoxyphenyl)methyl-2-di-phenylmethyl-1-  
azabicyclo[2.2.2]octan-3-amine;  
25           (2-methoxy-5-trifluoromethoxy-benzyl)-(2-phenyl-piperidin-3-yl)-amine;  
          (6-methoxy-1-methyl-1-trifluoromethyl-isochroman-7-ylmethyl)-(2-phenyl-piperidin-3-  
yl)-amine; and  
          (2S,3S)-N-(5-tert-butyl-2-methoxyphenyl)-methyl-2-diphenylmethyl-1-  
azabicyclo[2.2.2]octan-3-amine;  
30           and their pharmaceutically acceptable salts.

          The pharmaceutical compositions are useful in modulating cholinergic function in  
patients suffering from a disorder or condition selected from inflammatory bowel disease  
(including but not limited to ulcerative colitis, pyoderma gangrenosum and Crohn's disease),  
irritable bowel syndrome, spastic dystonia, chronic pain, acute pain, celiac sprue, pouchitis,  
35   vasoconstriction, anxiety, panic disorder, depression, bipolar disorder, autism, sleep  
disorders, jet lag, amyotrophic lateral sclerosis (ALS), cognitive dysfunction, hypertension,  
bulimia, anorexia, obesity, cardiac arrhythmias, gastric acid hypersecretion, ulcers,  
pheochromocytoma, progressive supranuclear palsy, chemical dependencies and addictions

5 (e.g., dependencies on, or addictions to nicotine (and/or tobacco products), alcohol, benzodiazepines, barbiturates, opioids or cocaine), headache, migraine, stroke, traumatic brain injury (TBI), obsessive-compulsive disorder (OCD), psychosis, Huntington's chorea, tardive dyskinesia, hyperkinesia, dyslexia, schizophrenia, multi-infarct dementia, age-related cognitive decline, epilepsy, including petit mal absence epilepsy, senile dementia of the  
10 Alzheimer's type (AD), Parkinson's disease (PD), attention deficit hyperactivity disorder (ADHD) and Tourette's Syndrome.

Another aspect of this invention is a method of modulating cholinergic function in a mammal comprising administering to the mammal, an amount of (a) a NRPA compound or a pharmaceutically acceptable salt thereof; and (b) an anti-emetic/anti-nausea agent; wherein  
15 the active ingredients (a) and (b) are administered in amounts that render the combination of the two ingredients effective in modulating cholinergic function in patients suffering from a disorder or condition selected from inflammatory bowel disease (including but not limited to ulcerative colitis, pyoderma gangrenosum and Crohn's disease), irritable bowel syndrome, spastic dystonia, chronic pain, acute pain, celiac sprue, pouchitis, vasoconstriction, anxiety,  
20 panic disorder, depression, bipolar disorder, autism, sleep disorders, jet lag, amyotrophic lateral sclerosis (ALS), cognitive dysfunction, hypertension, bulimia, anorexia, obesity, cardiac arrhythmias, gastric acid hypersecretion, ulcers, pheochromocytoma, progressive supranuclear palsy, chemical dependencies and addictions (e.g., dependencies on, or addictions to nicotine (and/or tobacco products), alcohol, benzodiazepines, barbiturates, opioids or cocaine),  
25 headache, migraine, stroke, traumatic brain injury (TBI), obsessive-compulsive disorder (OCD), psychosis, Huntington's chorea, tardive dyskinesia, hyperkinesia, dyslexia, schizophrenia, multi-infarct dementia, age-related cognitive decline, epilepsy, including petit mal absence epilepsy, senile dementia of the Alzheimer's type (AD), Parkinson's disease (PD), attention deficit hyperactivity disorder (ADHD) and Tourette's Syndrome.

30 The aryl fused azapolycyclic compounds selected from:

9-bromo-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-chloro-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-fluoro-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-ethyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
35 9-methyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-phenyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-vinyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;

- 5 9-bromo-3-methyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
3-benzyl-9-bromo-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
3-benzyl-9-chloro-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
10 9-acetyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-iodo-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-cyano-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-ethynyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
15 9-(2-propenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-(2-propyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-carbomethoxy-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-carboxyaldehyde-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
20 9-(2,6-difluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-phenyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-(2-fluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
25 9-(4-fluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-(3-fluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-(3,5-difluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
30 9-(2,4-difluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-(2,5-difluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
35 6-methyl-5-oxo-6,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,8-triene;  
5-oxo-6,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,8-triene;  
6-oxo-5,7,13-triazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,8-triene;  
4,5-difluoro-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;

- 5 5-fluoro-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene-4-carbonitrile;  
4-ethynyl-5-fluoro-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
5-ethynyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene-4-carbonitrile;  
6-methyl-5-thia-5-dioxa-6,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,8-  
triene;
- 10 10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
4-fluoro-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
4-methyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
4-trifluoromethyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
4-nitro-10-azatetracyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;
- 15 7-methyl-5,7,13-triazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,5,8-tetraene;  
6-methyl-5,7,13-triazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,5,8-tetraene;  
6,7-dimethyl-5,7,13-triazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,5,8-tetraene;  
6-methyl-7-phenyl-5,7,13-triazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,5,8-  
tetraene;
- 20 6,7-dimethyl-5,8,14-triazatetracyclo[10.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]hexadeca-2(11),3,5,7,9-pentaene;  
5,8,14-triazatetracyclo[10.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]hexadeca-2(11),3,5,7,9-pentaene;  
14-methyl-5,8,14-triazatetracyclo[10.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]hexadeca-2(11),3,5,7,9-pentaene;  
5-oxa-7,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,6,8-tetraene;  
6-methyl-5-oxa-7,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,6,8-tetraene;
- 25 4-chloro-10-azatetracyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
10-azatetracyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-trien-4-yl cyanide;  
1-(10-azatetracyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-trien-4-yl)-1-ethanone;  
10-azatetracyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-trien-4-ol;  
7-methyl-5-oxa-6,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2,4(8),6,9-tetraene;
- 30 4,5-dichloro-10-azatetracyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
11-azatetracyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene-5-carbonitrile;  
1-[11-azatetracyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-5-yl]-1-ethanone;  
1-[11-azatetracyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-5-yl]-1-propanone;  
4-fluoro-11-azatetracyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene-5-carbonitrile;
- 35 5-fluoro-11-azatetracyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene-4-carbonitrile;  
6-methyl-7-thia-5,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6-methyl-5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6,7-dimethyl-5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;

- 5 5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
5,6-dimethyl-5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,6,8-tetraene;  
5-methyl-5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,6,8-tetraene;  
6-(trifluoromethyl)-7-thia-5,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;
- 10 5,8,15-triazatetracyclo[11.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]heptadeca-2(11),3,5,7,9-pentaene;  
7-methyl-5,8,15-triazatetracyclo[11.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]heptadeca-2(11),3,5,7,9-pentaene;  
6-methyl-5,8,15-triazatetracyclo[11.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]heptadeca-2(11),3,5,7,9-pentaene;  
6,7-dimethyl-5,8,15-triazatetracyclo[11.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]heptadeca-2(11),3,5,7,9-pentaene;
- 15 7-oxa-5,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6-methyl-7-oxa-5,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
5-methyl-7-oxa-6,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6-methyl-5-oxa-7,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,6,8-tetraene;  
7-methyl-5-oxa-6,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,6,8-tetraene;
- 20 4,5-difluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
4-chloro-5-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
5-chloro-4-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
4-(1-ethynyl)-5-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
5-(1-ethynyl)-4-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;
- 25 5,6-difluoro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2,4,6-triene;  
6-trifluoromethyl-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2,4,6-triene;  
6-methoxy-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-6-ol;  
6-fluoro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;
- 30 11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-5-ol;  
4-nitro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
5-nitro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
5-fluoro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene; and  
6-hydroxy-5-methoxy-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene and
- 35 their pharmaceutically acceptable salts and their optical isomers.  
Preferably, the aryl fused azapolycyclic compounds are selected from:  
9-bromo-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-chloro-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;

- 5 9-fluoro-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2-a][1,5]diazocin-8-one;  
9-acetyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-iodo-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-cyano-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
9-carbomethoxy-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
10 9-carboxyaldehyde-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
one;  
9-(2,6-difluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
one;  
9-phenyl-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
15 9-(2-fluorophenyl)-1,2,3,4,5,6-hexahydro-1,5-methano-pyrido[1,2a][1,5]diazocin-8-one;  
one;  
6-methyl-5-thia-5-dioxa-6,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,8-triene;  
20 4-fluoro-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
4-trifluoromethyl-10-aza-tricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
4-nitro-10-azatricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-triene;  
6-methyl-5,7,13-triazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,5,8-tetraene;  
6,7-dimethyl-5,8,14-triazatetracyclo[10.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]hexadeca-2(11),3,5,7,9-pentaene;  
5,8,14-triazatetracyclo[10.3.1.0<sup>2,11</sup>.0<sup>4,9</sup>]hexadeca-2(11),3,5,7,9-pentaene;  
25 5-oxa-7,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,6,8-tetraene;  
6-methyl-5-oxa-7,13-diazatetracyclo[9.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]pentadeca-2(10),3,6,8-tetraene;  
10-azatricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-trien-4-yl cyanide;  
1-(10-azatricyclo[6.3.1.0<sup>2,7</sup>]dodeca-2(7),3,5-trien-4-yl)-1-ethanone;  
11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene-5-carbonitrile;  
30 1-[11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-5-yl]-1-ethanone;  
1-[11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-5-yl]-1-propanone;  
4-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene-5-carbonitrile;  
5-fluoro-11-azatricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene-4-carbonitrile;  
6-methyl-7-thia-5,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
35 6-methyl-5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6,7-dimethyl-5,7,14-triazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6-methyl-7-oxa-5,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,5,8-tetraene;  
6-methyl-5-oxa-7,14-diazatetracyclo[10.3.1.0<sup>2,10</sup>.0<sup>4,8</sup>]hexadeca-2(10),3,6,8-tetraene;

- 5        5,6-difluoro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2,4,6-triene;  
6-trifluoromethyl-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2,4,6-triene;  
6-methoxy-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene;  
6-fluoro-11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-triene; and  
11-aza-tricyclo[7.3.1.0<sup>2,7</sup>]trideca-2(7),3,5-trien-5-ol  
10        and their pharmaceutically acceptable salts and their optical isomers.

The anti-emetics/anti-nausea agents are selected from the group consisting of: bismuth subsalicylate (Pepto-Bismol), chlorpromazine (Thorazine), dextrose/levulose/phosphoric acid (Emetrol), dimenhydrinate (Dramamine), diphenhydramine (Benadryl), dolasetron (Anzemet), dronabinol (Marinol), granisetron (Kytril), hydroxyzine (Atarax/Vistaril), meclizine  
15 (Antivert/Bonine), metoclopramide (Reglan), ondansetron (Zofran), perphenazine (Trilafon), prochlorperazine (Compazine), promethazine (Phenergan), scopolamine (Transderm Scop), trimethobenzamide (Tigan).

- Other anti-emetics/anti-nausea agents are selected from the group consisting of:  
20 (2S,3S)-3-(5-tert-butyl-2-methoxybenzyl)amino-2-(3-trifluoromethoxyphenyl)piperidine;  
(2S,3S)-3-(2-isopropoxy-5-trifluoromethoxybenzyl)amino-2-phenyl-piperidine;  
(2S,3S)-3-(2-ethoxy-5-trifluoromethoxybenzyl)amino-2-phenyl-piperidine;  
(2S,3S)-3-(2-methoxy-5-trifluoromethoxybenzyl)-amino-2-phenylpiperidine;  
(2S,3S)-3-(5-tert-butyl-2-trifluoromethoxybenzyl)amino-2-phenylpiperidine;  
2-(diphenylmethyl)-N-(2-methoxy-5-trifluoromethoxy-phenyl)methyl-1-  
25 azabicyclo[2.2.2]octan-3-amine;  
(2S,3S)-3-[5-chloro-2-(2,2,2-trifluoroethoxy)-benzyl]amino-2-phenylpiperidine;  
(2S,3S)-3-(5-tert-butyl-2-trifluoromethoxybenzyl)amino-2-phenylpiperidine;  
(2S,3S)-3-(2-isopropoxy-5-trifluoromethoxybenzyl)amino-2-phenylpiperidine;  
(2S,3S)-3-(2-difluoromethoxy-5-trifluoromethoxybenzyl)-amino-2-phenylpiperidine;  
30 (2S,3S)-2-phenyl-3-[2-(2,2,2-trifluoroethoxybenzyl)-aminopiperidine; or  
(2S,3S)-2-phenyl-3-(2-trifluoromethoxybenzyl)]aminopiperidine;  
3-[N-(2-methoxy-5-trifluoromethoxybenzyl)-amino]-5,5-dimethyl-2-phenylpyrrolidine;  
3-[N-(2-methoxy-5-trifluoromethoxy-benzyl)amino]-4,5-dimethyl-2-phenylpyrrolidine;  
3-(2-cyclopropyloxy-5-trifluoromethoxybenzyl)amino-2-phenylpiperidine;  
35 3-(2-cyclopropylmethoxy-5-trifluoromethoxybenzyl)amino-2-phenylpiperidine;  
3-(2-difluoromethoxy-5-phenylbenzyl)amino-2-phenylpiperidine;  
3-(5-cyclopropylmethoxy-2-difluoromethoxybenzyl)amino-2-phenylpiperidine;  
3-(2-methoxybenzyl)amino-2-(3-trifluoromethoxyphenyl)-piperidine;



- 5           3-(2-methoxy-5-trifluoromethoxybenzyl)amino-2-(3-trifluoromethoxyphenyl)piperidine;  
2-phenyl-3-(5-n-propyl-2-trifluoromethoxybenzyl)amino-piperidine;  
(2-methoxy-5-trifluoromethoxy-benzyl)-(2-phenyl-piperidin-3-yl)-amine;  
5-[(6-ethyl-2-phenyl-piperidin-3-ylamino)-methyl]-6-methoxy-3-methyl-1,1a,3,7b-  
tetrahydro-3-aza-cyclopropa[a]naphthalen-2-one;
- 10           (6-methoxy-1-methyl-1-trifluoromethyl-isochroman-7-ylmethyl)-(2-phenyl-piperidin-3-  
yl)-amine;  
3-(5-isopropyl-2-trifluoromethoxybenzyl)amino-2-phenylpiperidine;  
3-(5-ethyl-2-trifluoromethoxybenzyl)amino-2-phenyl-piperidine;  
3-(5-sec-butyl-2-trifluoromethoxybenzyl)amino-2-phenyl-piperidine;
- 15           3-(5-difluoromethoxy-2-methoxybenzyl)amino-2-phenyl-piperidine;  
3-(2-methoxy-5-trifluoromethoxybenzyl)amino-2-phenylpyrrolidine;  
3-(2-methoxy-5-trifluoromethoxybenzyl)amino-2-phenylhomopiperidine;  
2-benzhydryl-3-(2-methoxy-5-trifluoromethoxy-benzyl)aminopyrrolidine;  
2-benzhydryl-3-(2-methoxy-5-trifluoromethoxy-benzyl)aminohomopiperidine;
- 20           3-[2,5-bis-(2,2,2-trifluoroethoxy)benzyl]amino-2-phenylpiperidine;  
2-phenyl-3-(3-trifluoromethoxybenzyl)aminopiperidine;  
2-benzhydryl-3-(2-methoxy-5-trifluoromethoxybenzyl)-aminopiperidine;  
1-(5,6-difluorohexyl)-3-(2-methoxy-5-trifluoromethoxy-benzyl)amino-2-phenylpiperidine;  
1-(6-hydroxyhexyl)-3-(2-methoxy-5-trifluoromethoxy-benzyl)amino-2-phenylpiperidine;
- 25           3-phenyl-4-(2-methoxy-5-trifluoromethoxybenzyl)amino-2-azabicyclo[3.3.0]octane;  
4-benzhydryl-5-(2-methoxy-5-trifluoromethoxybenzyl)-amino-3-  
azabicyclo[4.1.0]heptane;  
4-(2-methoxy-5-trifluoromethoxybenzyl)amino-3-phenyl-2-azabicyclo[4.4.0]decane;  
2-phenyl-3-(2-methoxy-5-trifluoromethoxybenzyl)-aminoquinuclidine;
- 30           8-benzhydryl-N-(2-methoxy-5-trifluoromethoxybenzyl)-9-azatricyclo[4.3.1.0<sup>4,9</sup>]decan-7-  
amine;  
9-benzhydryl-N-(2-methoxy-5-trifluoromethoxybenzyl)-10-  
azatricyclo[4.4.1.0<sup>5,10</sup>]undecan-8-amine;
- 35           9-benzhydryl-N-(2-methoxy-5-trifluoromethoxybenzyl)-3-thia-10-azatricyclo-  
[4.4.1.0<sup>5,10</sup>]undecan-8-amine;  
8-benzhydryl-N-(2-methoxy-5-trifluoromethoxybenzyl)-9-azatricyclo[4.3.1.0<sup>4,9</sup>]decan-7-  
amine;

- 5           5,6-pentamethylene-2-benzhydryl-3-(2-methoxy-5-trifluoromethoxybenzyl)amino-  
quinuclidine;  
          5,6-trimethylene-2-benzhydryl-3-(2-methoxy-5-trifluoromethoxybenzyl)amino-  
quinuclidine;  
          9-benzhydryl-N-((2-methoxy-5-trifluoromethoxyphenyl)-methyl)-3-oxa-10-azatricyclo-  
10 [4.4.1.0<sup>5,10</sup>]undecan-3-amine;  
          8-benzhydryl-N-((2-methoxy-5-trifluoromethoxyphenyl)-methyl)-7-azatricyclo-  
[4.4.1.0<sup>5,10</sup>]undecan-9-amine; and  
          2-benzhydryl-N-((2-methoxy-5-trifluoromethoxyphenyl)-methyl)-1-azabicyclo-  
[3.2.2]nonan-3-amine;  
15           (2S,3S)-3-(6-methoxy-1-methyl-1-trifluoromethylisochroman-7-yl)methylamino-2-  
phenylpiperidine;  
          (2S,3S)-3-[(1R)-6-methoxy-1-methyl-1-trifluoromethylisochroman-7-yl]methylamino-2-  
phenylpiperidine;  
          (2S,3S)-N-(5-isopropyl-2-methoxyphenyl)methyl-2-diphenylmethyl-1-azabicyclo[2.2.2]-  
20 octan-3-amine; and  
          (2S,3S)-N-(5-tert-butyl-2-methoxyphenyl)-methyl-2-diphenylmethyl-1-azabicyclo[2.2.2]-  
octan-3-amine;  
          and their pharmaceutically acceptable salts.

          The pharmaceutical composition is used for modulating cholinergic function in patients  
25 suffering from a disorder or condition selected from inflammatory bowel disease (including but  
not limited to ulcerative colitis, pyoderma gangrenosum and Crohn's disease), irritable bowel  
syndrome, spastic dystonia, chronic pain, acute pain, celiac sprue, pouchitis, vasoconstriction,  
anxiety, panic disorder, depression, bipolar disorder, autism, sleep disorders, jet lag,  
amyotrophic lateral sclerosis (ALS), cognitive dysfunction, hypertension, bulimia, anorexia,  
30 obesity, cardiac arrhythmias, gastric acid hypersecretion, ulcers, pheochromocytoma,  
progressive supranuclear palsy, chemical dependencies and addictions (e.g., dependencies  
on, or addictions to nicotine (and/or tobacco products), alcohol, benzodiazepines,  
barbiturates, opioids or cocaine), headache, migraine, stroke, traumatic brain injury (TBI),  
obsessive-compulsive disorder (OCD), psychosis, Huntington's chorea, tardive dyskinesia,  
35 hyperkinesia, dyslexia, schizophrenia, multi-infarct dementia, age-related cognitive decline,  
epilepsy, including petit mal absence epilepsy, senile dementia of the Alzheimer's type (AD),  
Parkinson's disease (PD), attention deficit hyperactivity disorder (ADHD) and Tourette's  
Syndrome.

5       The method comprises administering to a mammal a cholinergic modulating effective amount of the above pharmaceutical composition comprising (a) a NRPA compound or pharmaceutically acceptable salt thereof; (b) an anti-emetic/anti-nausea drug or a pharmaceutically acceptable salt thereof and a pharmaceutically acceptable carrier. In the pharmaceutical composition (a) and (b) are present in amounts that render the composition  
10       effective in treating such disorders or conditions mention above.

      A method of treating a disorder or condition selected from inflammatory bowel disease (including but not limited to ulcerative colitis, pyoderma gangrenosum and Crohn's disease), irritable bowel syndrome, spastic dystonia, chronic pain, acute pain, celiac sprue, pouchitis, vasoconstriction, anxiety, panic disorder, depression, bipolar disorder, autism, sleep  
15       disorders, jet lag, amyotrophic lateral sclerosis (ALS), cognitive dysfunction, hypertension, bulimia, anorexia, obesity, cardiac arrhythmias, gastric acid hypersecretion, ulcers, pheochromocytoma, progressive supranuclear palsy, chemical dependencies and addictions (e.g., dependencies on, or addictions to nicotine (and/or tobacco products), alcohol, benzodiazepines, barbiturates, opioids or cocaine), headache, migraine, stroke, traumatic  
20       brain injury (TBI), obsessive-compulsive disorder (OCD), psychosis, Huntington's chorea, tardive dyskinesia, hyperkinesia, dyslexia, schizophrenia, multi-infarct dementia, age-related cognitive decline, epilepsy, including petit mal absence epilepsy, senile dementia of the Alzheimer's type (AD), Parkinson's disease (PD), attention deficit hyperactivity disorder (ADHD) and Tourette's Syndrome comprises administering to a mammal (a) a NRPA  
25       compound or a pharmaceutically acceptable salt thereof; (b) an anti-emetic/anti-nausea drug; where in the active agents (a) and (b) above are administered in amounts that render the combination of the two ingredients effective in treating the above disease or condition.

      The term "treating", "treat" or "treatment" as used herein includes preventive (e.g., prophylactic) and palliative treatment.

30       The chemist of ordinary skill will recognize that certain compounds of this invention will contain one or more atoms which may be in a particular stereochemical or geometric configuration, giving rise to stereoisomers and configurational isomers. All such isomers and mixtures thereof are included in this invention. Hydrates of the compounds of this invention are also included.

35       The chemist of ordinary skill will recognize that certain combinations of heteroatom-containing substituents listed in this invention define compounds which will be less stable under physiological conditions (e.g. those containing acetal or aminal linkages). Accordingly, such compounds are less preferred.

5

Detailed Description of the Invention

NRPA compounds, their optical isomers or a pharmaceutically acceptable salt of the forgoing compounds may be used in this invention. NRPA compounds are chemical compounds that bind to neuronal nicotinic receptor sites and elicit a partial agonist response.

10 The particular NRPA compounds listed above, which can be employed in the methods and pharmaceutical compositions of this invention, can be made by processes known in the chemical arts, for example by the methods described in WO 9818798 A1, WO 9935131-A1 and WO9955680-A1 and incorporated by reference herein. Some of the preparation methods useful for making the compounds of this invention may require protection of remote functionality (i.e., primary amine, secondary amine, carboxyl). The need for such protection will vary  
15 depending on the nature of the remote functionality and the conditions of the preparation methods. The need for such protection is readily determined by one skilled in the art, and is described in examples carefully described in the above cited applications. The starting materials and reagents for the NRPA compounds employed in this invention are also readily available or can be easily synthesized by those skilled in the art using conventional methods of organic  
20 synthesis. Some of the compounds used herein are related to, or are derived from compounds found in nature and accordingly many such compounds are commercially available or are reported in the literature or are easily prepared from other commonly available substances by methods which are reported in the literature.

The above anti-nausea/anti-emetic agents can be prepared as described in United  
25 States Patent Application 09/848069 filed May 3, 2001.

Other examples of anti-emetic/anti-nausea agents that can be used in the methods and pharmaceutical composition of this invention are those referred to in the following references, all of which are incorporated herein by reference in their entireties: United States Patent 5,162,339, which issued on November 11, 1992; United States Patent 5,232,929, which  
30 issued on August 3, 1993; World Patent Application WO 92/20676, published November 26, 1992; World Patent Application WO 93/00331, published January 7, 1993; U.S. Patent No. 5,773,450, World Patent Application WO 92/21677, published December 10, 1992; World Patent Application WO 93/00330, published January 7, 1993; World Patent Application WO 93/06099, published April 1, 1993; World Patent Application WO 93/10073, published May 27, 1993; World  
35 Patent Application WO 92/06079, published April 16, 1992; World Patent Application WO 92/12151, published July 23, 1992; World Patent Application WO 92/15585, published September 17, 1992; World Patent Application WO 93/10073, published May 27, 1993; World Patent Application WO 93/19064, published September 30, 1993; World Patent Application WO

5 94/08997, published April 28, 1994; World Patent Application WO 94/04496, published March 3, 1994; United States Patent Application 988,653, filed December 10, 1992; United States Patent Application 026,382, filed March 4, 1993; United States Patent Application 123,306, filed September 17, 1993, and United States Patent Application 072,629, filed June 4, 1993. All of the foregoing World Patent Applications designate the United States and were filed in the U.S. Receiving Office of the PCT. : European Patent Application EP 499,313, published August 19, 10 1992; European Patent Application EP 520,555, published December 30, 1992; European Patent Application EP 522,808, published January 13, 1993; European Patent Application EP 528,495, published February 24, 1993; PCT Patent Application WO 93/14084, published July 22, 1993; PCT Patent Application WO 93/01169, published January 21, 1993; PCT Patent Application WO 93/01165, published January 21, 1993; PCT Patent Application WO 93/01159, published January 21, 1993; PCT Patent Application WO 92/20661, published November 26, 1992; European Patent Application EP 517,589; published December 12, 1992; European Patent Application EP 428,434, published May 22, 1991; European Patent Application EP 360,390, published March 28, 1990; PCT Patent Application WO 95/19344, published July 20, 20 1995; PCT Patent Application WO 95/23810, published September 8, 1995; PCT Patent Application WO 95/20575, published August 3, 1995; and PCT Patent Application WO 95/28418, published October 26, 1995 and PCT Patent Application WO 95/08549 published March 20, 1995.

Additional known anti-nausea/anti-emetic compounds are useful in this invention. 25 They include but are not limited to bismuth subsalicylate (Pepto-Bismol), chlorpromazine (Thorazine), dextrose/levulose/phosphoric acid (Emetrol), dimenhydrinate (Dramamine), diphenhydramine (Benadryl), dolasetron (Anzemet), dronabinol (Marinol), granisetron (Kytril), hydroxyzine (Atarax/Vistaril), meclizine (Antivert/Bonine), metoclopramide (Reglan), ondansetron (Zofran), perphenazine (Trilafon), prochlorperazine (Compazine), promethazine 30 (Phenergan), scopolamine (Transderm Scop) and trimethobenzamide (Tigan).

In general, the compounds of this invention can be made by processes which include processes known in the chemical arts, particularly in light of the description contained herein.

Some of the preparation methods useful for making the compounds of this invention may require protection of remote functionality (i.e., primary amine, secondary amine, carboxyl). 35 The need for such protection will vary depending on the nature of the remote functionality and the conditions of the preparation methods. The need for such protection is readily determined by one skilled in the art. For a general description of protecting groups and their use, see T.W. Greene, Protective Groups in Organic Synthesis, John Wiley & Sons, New York, 1991. The

5 starting materials and reagents for the compounds of this invention are also readily available or  
can be easily synthesized by those skilled in the art using conventional methods of organic  
synthesis. For example, many of the compounds used herein are related to, or are derived from  
compounds found in nature, in which there is a large scientific interest and commercial need,  
and accordingly many such compounds are commercially available or are reported in the  
10 literature or are easily prepared from other commonly available substances by methods which  
are reported in the literature.

Some of the NRPA compounds of this invention are ionizable at physiological  
conditions. Thus, for example some of the compounds of this invention are acidic and they form  
a salt with a pharmaceutically acceptable cation. All such salts are within the scope of this  
15 invention and they can be prepared by conventional methods. For example, they can be  
prepared simply by contacting the acidic and basic entities, usually in a stoichiometric ratio, in  
either an aqueous, non-aqueous or partially aqueous medium, as appropriate. The salts are  
recovered either by filtration, by precipitation with a non-solvent followed by filtration, by  
evaporation of the solvent, or, in the case of aqueous solutions, by lyophilization, as appropriate.

20 In addition, some of the compounds of this invention are basic, and they form a salt with  
a pharmaceutically acceptable anion. All such salts are within the scope of this invention and  
they can be prepared by conventional methods. For example, they can be prepared simply by  
contacting the acidic and basic entities, usually in a stoichiometric ratio, in either an aqueous,  
non-aqueous or partially aqueous medium, as appropriate. The salts are recovered either by  
25 filtration, by precipitation with a non-solvent followed by filtration, by evaporation of the solvent,  
or, in the case of aqueous solutions, by lyophilization, as appropriate.

In addition, when the compounds of this invention form hydrates or solvates they are  
also within the scope of the invention.

Nicotinic agents are known to induce nausea and emesis (R. B. Barlow, L. J. McLeod,  
30 *Brit. J. Pharmacol.* **35**, 161, (1969). Amelioration of these effects would improve toleration of  
nicotinic agents and in particular NRPA's and therefore the therapeutic efficacy of NRPA agents  
in mammals.

The utility of the NRPA compounds employed in the present invention as medicinal  
agents in the treatment of ADHD mammals (e.g. humans) is demonstrated by the activity of  
35 the compounds of this invention in conventional assays and, in particular the assays  
described below. Such assays also provide a means whereby the activities of the compounds  
of this invention can be compared between themselves and with the activities of other known

- 5 compounds. The results of these comparisons are useful for determining dosage levels in mammals, including humans, for the treatment of such diseases.

#### Biological Assays

##### Procedures

Nicotinic receptor binding assay. The effectiveness of the active compounds in  
10 suppressing nicotine binding to specific receptor sites is determined by the following procedure which is a modification of the methods of Lippiello, P. M. and Fernandes, K. G. (in The Binding of L-[<sup>3</sup>H]Nicotine To A Single Class of High-Affinity Sites in Rat Brain Membranes, Molecular Pharm., 29, 448-54, (1986)) and Anderson, D. J. and Arneric, S. P. (in Nicotinic Receptor Binding of <sup>3</sup>H-Cytisine, <sup>3</sup>H-Nicotine and <sup>3</sup>H-Methylcarbamylcholine In Rat Brain, European J.  
15 Pharm., 253, 261-67 (1994)). Male Sprague-Dawley rats (200-300 g) from Charles River were housed in groups in hanging stainless steel wire cages and were maintained on a 12 hour light/dark cycle (7 a.m.-7 p.m. light period). They received standard Purina Rat Chow and water *ad libitum*. The rats were killed by decapitation. Brains were removed immediately following decapitation. Membranes were prepared from brain tissue according to the methods of Lippiello  
20 and Fernandez (Molec Pharmacol, 29, 448-454, (1986) with some modifications. Whole brains were removed, rinsed with ice-cold buffer, and homogenized at 0° in 10 volumes of buffer (w/v) using a Brinkmann Polytron™, setting 6, for 30 seconds. The buffer consisted of 50 mM Tris HCl at a pH of 7.5 at room temperature. The homogenate was sedimented by centrifugation (10 minutes; 50,000 x g; 0° to 4°C). The supernatant was poured off and the membranes were  
25 gently resuspended with the Polytron and centrifuged again (10 minutes; 50,000 x g; 0 to 4°C. After the second centrifugation, the membranes were resuspended in assay buffer at a concentration of 1.0g/100mL. The composition of the standard assay buffer was 50 mM Tris HCl, 120 mM NaCl, 5 mM KCl, 2 mM MgCl<sub>2</sub>, 2 mM CaCl<sub>2</sub> and has a pH of 7.4 at room temperature.

30 Routine assays were performed in borosilicate glass test tubes. The assay mixture typically consisted of 0.9 mg of membrane protein in a final incubation volume of 1.0 mL. Three sets of tubes were prepared wherein the tubes in each set contained 50µL of vehicle, blank, or test compound solution, respectively. To each tube was added 200µL of [<sup>3</sup>H]-nicotine in assay buffer followed by 750µL of the membrane suspension. The final concentration of nicotine in  
35 each tube was 0.9 nM. The final concentration of cytisine in the blank was 1µM. The vehicle consisted of deionized water containing 30µL of 1 N acetic acid per 50 mL of water. The test compounds and cytisine were dissolved in vehicle. Assays were initiated by vortexing after addition of the membrane suspension to the tube. The samples were incubated at 0° to 4° C in

5 an iced shaking water bath. Incubations were terminated by rapid filtration under vacuum through Whatman GF/B™ glass fiber filters using a Brandel™ multi-manifold tissue harvester. Following the initial filtration of the assay mixture, filters were washed two times with ice-cold assay buffer (5 ml each). The filters were then placed in counting vials and mixed vigorously with 20 ml of Ready Safe™ (Beckman) before quantification of radioactivity. Samples were counted  
10 in a LKB Wallach Rackbeta™ liquid scintillation counter at 40-50% efficiency. All determinations were in triplicate.

Calculations: Specific binding (C) to the membrane is the difference between total binding in the samples containing vehicle only and membrane (A) and non-specific binding in the samples containing the membrane and cytosine (B), i.e.,

15 Specific binding = (C) = (A) - (B).

Specific binding in the presence of the test compound (E) is the difference between the total binding in the presence of the test compound (D) and non-specific binding (B), i.e., (E) = (D) - (B).

% Inhibition =  $(1 - ((E)/(C)))$  times 100.

20 The compounds of the invention that were tested in the above assay exhibited IC<sub>50</sub> values of less than 10 μM.

Dopamine Turnover: Rats were injected s.c. or p.o. (gavage) and then decapitated either 1 or 2 hours later. Nucleus accumbens was rapidly dissected (2 mm slices, 4°C, in 0.32 M sucrose), placed in 0.1 N perchloric acid, and then homogenized. After centrifugation  
25 10 μL of the supernatant was assayed by HPLC-ECD. Turnover/ utilization of dopamine (DA) was calculated as the ratio of tissue concentrations of metabolites ([DOPAC]+[HVA]) to DA and expressed as percent of control.

#### Assays for Anti-Emetic/Anti-Nausea Agents

The utility of the anti-emetic/anti-nausea compounds employed in the present  
30 invention as medicinal agents can be measured as described below.

Male ferrets (650-1410 g) are fasted or non-fasted overnight and are dosed with either compound or vehicle (water). Compounds are given orally, subcutaneously or intra-duodenal at doses from 0.01 to 10.0 mg/kg and dose volumes from 5 to 25 ml/kg.

For the antagonism studies, ondansetron (0.1 to 1 mg/kg) or vehicle (saline or  
35 sterilized water) is administered s.c. at -30 and -5 minutes compound at various doses. CuSO<sub>4</sub> (12.5 mg/kg; 5 ml/kg) is used as a positive control.

For the intra-duodenal administration studies, ferrets we are surgically implanted with a catheter placed into the duodenum at least 7 days before the studies. The catheter is



5 attached to a vascular access port subcutaneously on the dorsolateral aspect of the thorax. Intra-duodenal catheters are flushed with approximately 1.5 ml of saline before and after the dosing of the compound or  $\text{CuSO}_4$  i.d. Intra-duodenal ports are flushed with 3 ml of saline after the experiment is over.

10 Studies utilize a randomized, cross-over study design where each ferret receives one treatment per week and only one treatment per study. Following dosing, ferrets are placed in polycarbonate cages (19" x 10 1/2" x 8") for an observational period of 60 minutes. The following are scored: (1) productive vomiting with one or more abdominal movements seen, (2) non-productive vomiting where the animal makes multiple abdominal movements associated with retching and open mouth display, or (3) non-productive vomiting where the  
15 animal made an abdominal movement or shoulder movement with open mouth display with a choking or gagging sound. Additional behaviors are to be noted with gagging were (1) scratching the roof of the mouth with a front paw, and (2) grasping the side of the mouth with the front paws. Animals are checked periodically throughout the day for signs of emesis in home cages. Ferrets are placed in experimental cages for approximately 20 minutes before  
20 dosing of compound or vehicle. The total duration of each study is 4 weeks of treatment and in the 5<sup>th</sup> week, each ferret is anesthetized and blood collected by cardiac puncture. Blood is centrifuged and plasma separated for the determination of compound exposures.

The calculation of mean and total number of retches includes responder animals only. Total # of retches and emesis is measured within 60 min post dose.

25 The combination of the NRPA compound and an anti-emetic/anti-nausea agent will result in increased efficacy with effective control of nausea. In addition, such a combination allows higher, more efficacious doses of the NRPA agent to be administered, resulting in greater efficacy with fewer side effects (or a higher therapeutic index).

30 The results of these comparisons are useful for determining dosage levels in mammals, including humans, for the treatment of such diseases.

Administration of the compositions of this invention can be via any method which delivers a compound of this invention systemically and/or locally. These methods include oral routes and transdermal routes, etc. Generally, the compounds of this invention are administered orally, but parenteral administration may be utilized (e.g., intravenous, intramuscular,  
35 subcutaneous or intramedullary). The two different compounds of this invention can be co-administered simultaneously or sequentially in any order, or a single pharmaceutical composition comprising a NRPA compound described above and an anti-emetic/anti-nausea agent as described above in a pharmaceutically acceptable carrier can be administered.

5           The amount and timing of compounds administered will, of course, be based on the judgement of the prescribing physician. Thus, because of patient to patient variability, the dosages given below are a guideline and the physician may titrate doses of the agent to achieve the activity that the physician considers appropriate for the individual patient. In considering the degree of activity desired, the physician must balance a variety of factors such as cognitive  
10   function, age of the patient, presence of preexisting disease, as well as presence of other diseases (e.g., cardiovascular). The following paragraphs provide preferred dosage ranges for the various components of this invention (based on average human weight of 70 kg).

          In general, an effective dosage for the NRPA compounds in the range of 0.001 to 200 mg/kg/day, preferably 0.01 to 10.0 mg/kg/day.

15           In general an effective dosage for the anti-emetic/anti-nausea agents are as follows:

          bismuth subsalicylate (Pepto-Bismol), 3 to 60 mg/kg/day  
          chlorpromazine (Thorazine), 0.1 to 6 mg/kg/day  
          dextrose/levulose/phosphoric acid (Emetrol), 1 - 10 tablespoon/day  
          dimenhydrinate (Dramamine), 0.1 to 6 mg/kg/day  
20          diphenhydramine (Benadryl), 0.1 to 2 mg/kg/day  
          dolasetron (Anzemet), 0.1 to 1.8 mg/kg, up to 100 mg total dose.  
          dronabinol (Marinol), 0.05 - 0.3 mg/kg/day  
          granisetron (Kytril), 0.001 to 0.03 mg/kg/day  
          hydroxyzine (Atarax/Vistaril), 0.1 to 6 mg/kg/day  
25          meclizine (Antivert/Bonine), 0.1 to 1.5 mg/kg/day  
          metoclopramide (Reglan), 0.1 to 2 mg/kg/day  
          ondansetron (Zofran), 0.01 - 0.34 mg/kg/day  
          perphenazine (Trilafon), 0.01 to 0.23 mg/kg/day  
          prochlorperazine (Compazine), 0.05 to 6 mg/kg/day  
30          promethazine (Phenergan), 0.1 to 1.5 mg/kg/day  
          scopolamine (Transderm Scop), 1.0 to 5.0 ug/kg/day  
          trimethobenzamide (Tigan) 1.0 to 14.3 mg/kg/day

          In general an effective dosage for the other anti-emetic/anti-nausea agents listed are as follows: These compounds are most desirably administered in dosages ranging from about 5.0  
35   mg up to about 1500 mg per day, although variations will necessarily occur depending upon the weight and condition of the subject being treated and the particular route of administration chosen. However, a dosage level that is in the range of about 0.07 mg to about 21 mg per kg of body weight per day is most desirably employed. Variations may nevertheless occur depending

5 upon the species of animal being treated and its individual response to said medicament, as well  
as on the type of pharmaceutical formulation chosen and the time period and interval at which  
such administration is carried out. In some instances, dosage levels below the lower limit of the  
aforesaid range may be more than adequate, while in other cases still larger doses may be  
employed without causing any harmful side effect, provided that such larger doses are first  
10 divided into several small doses for administration throughout the day.

The compositions of the present invention are generally administered in the form of a  
pharmaceutical composition comprising at least one of the compounds of this invention together  
with a pharmaceutically acceptable vehicle or diluent. Thus, the compounds of this invention  
can be administered individually or together in any conventional oral, parenteral or transdermal  
15 dosage form.

For oral administration a pharmaceutical composition can take the form of solutions,  
suspensions, tablets, pills, capsules, powders, and the like. Tablets containing various excipients  
such as sodium citrate, calcium carbonate and calcium phosphate are employed along with  
various disintegrants such as starch and preferably potato or tapioca starch and certain complex  
20 silicates, together with binding agents such as polyvinylpyrrolidone, sucrose, gelatin and acacia.  
Additionally, lubricating agents such as magnesium stearate, sodium lauryl sulfate and talc are  
often very useful for tableting purposes. Solid compositions of a similar type are also employed  
as fillers in soft and hard-filled gelatin capsules; preferred materials in this connection also  
include lactose or milk sugar as well as high molecular weight polyethylene glycols. When  
25 aqueous suspensions and/or elixirs are desired for oral administration, the compounds of this  
invention can be combined with various sweetening agents, flavoring agents, coloring agents,  
emulsifying agents and/or suspending agents, as well as such diluents as water, ethanol,  
propylene glycol, glycerin and various like combinations thereof.

For purposes of parenteral administration, solutions in sesame or peanut oil or in  
30 aqueous propylene glycol can be employed, as well as sterile aqueous solutions of the  
corresponding water-soluble salts. Such aqueous solutions may be suitably buffered, if  
necessary, and the liquid diluent first rendered isotonic with sufficient saline or glucose. These  
aqueous solutions are especially suitable for intravenous, intramuscular, subcutaneous and  
intraperitoneal injection purposes. In this connection, the sterile aqueous media employed are all  
35 readily obtainable by standard techniques well-known to those skilled in the art.

For purposes of transdermal (e.g., topical) administration, dilute sterile, aqueous or  
partially aqueous solutions (usually in about 0.1% to 5% concentration), otherwise similar to the  
above parenteral solutions, are prepared.

5           Methods of preparing various pharmaceutical compositions with a certain amount of active ingredient are known, or will be apparent in light of this disclosure, to those skilled in this art. For examples, see Remington's Pharmaceutical Sciences, Mack Publishing Company, Easter, Pa., 15th Edition (1975).

10           Pharmaceutical compositions according to the invention may contain 0.1%-95% of the compound(s) of this invention, preferably 1%-70%. In any event, the composition or formulation to be administered will contain a quantity of a compound(s) according to the invention in an amount effective to treat the disease/condition of the subject being treated.